



# **Armed Forces College of Medicine AFCM**



# **Reflex action and its properties**

**Prof. Abdelrahman Fahmy**

# INTENDED LEARNING OBJECTIVES (ILOs)



By the end of this lecture the student will be able to:

1. Identify components and types of reflex arc
2. Explain the properties of reflex action:
  - ✓ Forward direction
  - ✓ Reflex delay
  - ✓ Reflex fatigue
  - ✓ Summation
  - ✓ Irradiation
  - ✓ Reciprocal innervation
  - ✓ Recruitment
  - ✓ After discharge
  - ✓ Discharge zone & subliminal fringe zone
  - ✓ occlusion
  - ✓ Facilitation

# REFLEX ARC



• **Def.:** It is the functional and structural unit of CNS.

• **Components:** Receptor, afferent, interneuron, efferent, and effectors organ.

• **Bell Magendi Law:** States that the dorsal root is sensory, while the ventral root is motor.

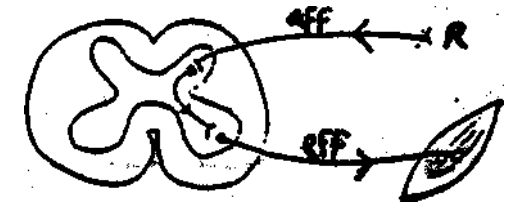
• **Functions of interneuron's:**

**a-Divergence** = to magnify spread of response.

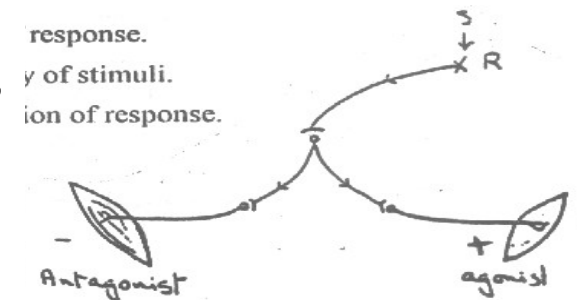
**b- Convergence** = to Magnify intensity of stimuli.

**c- After discharge** = to magnify response.

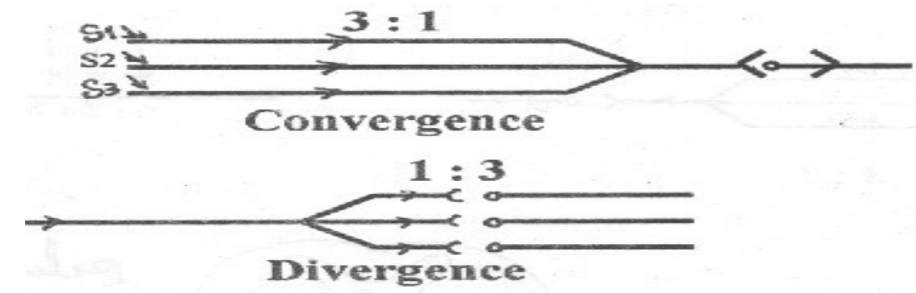
**d-Interneuronal inhibition.**



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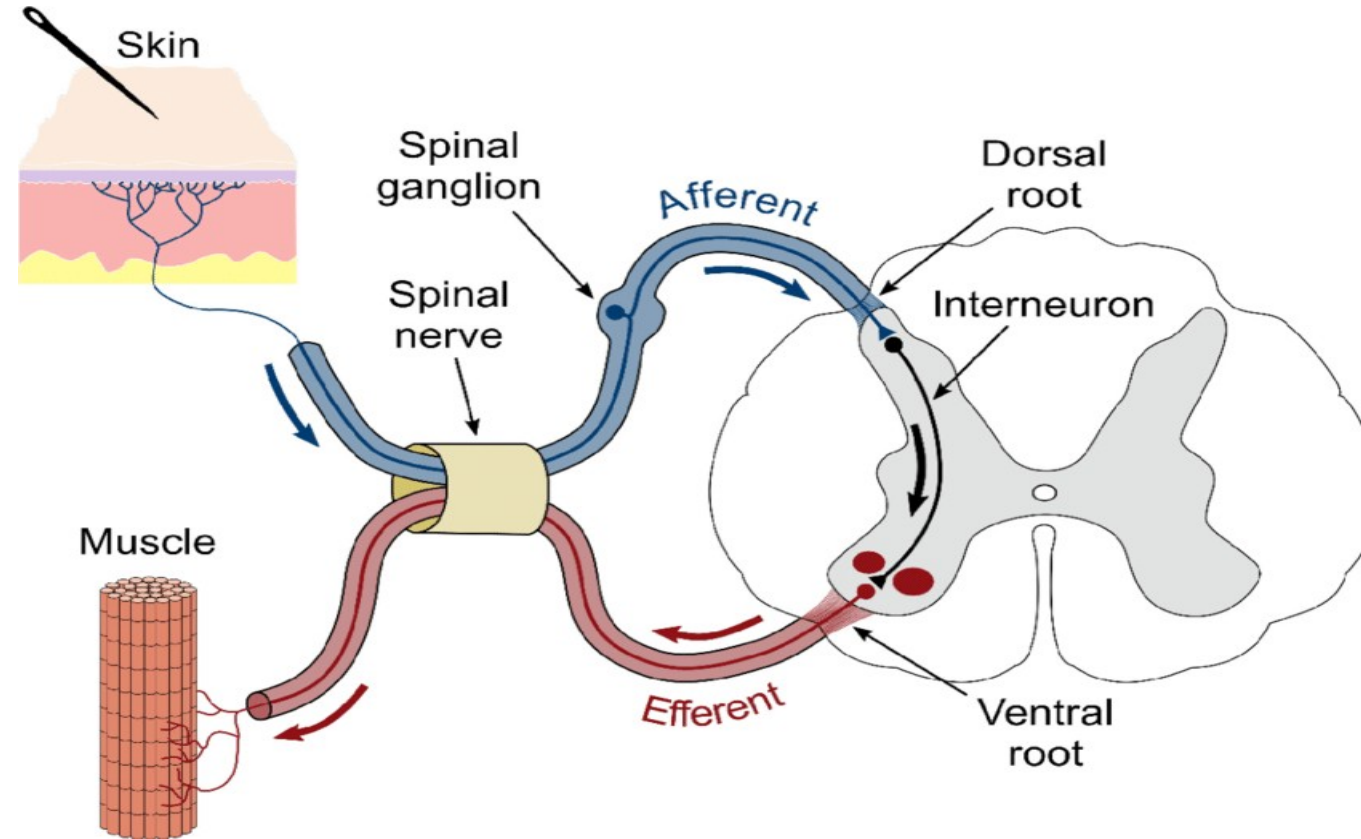


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# REFLEX ARC



[https://www.researchgate.net/figure/Schematic-representation-of-a-spinal-reflex-arc-A-pin-in-the-skin-produces-an-input\\_fig1\\_327199446](https://www.researchgate.net/figure/Schematic-representation-of-a-spinal-reflex-arc-A-pin-in-the-skin-produces-an-input_fig1_327199446)

## ***Properties of reflex Action***



- 1- Law of forward conduction.
- 2- Reflex delay
- 3- Reflex fatigue
- 4- Summation.
- 5- Irradiation & rebound.
- 6- Reciprocal innervation. 
- 7- Recruitment.
- 8- After discharge.
- 9- Discharge zone & Subliminal fringe.
- 10- Occlusion
- 11- Facilitation.

# *Properties of reflex Action*



## 1) Law of forward conduction:

Impulses pass from pre-synaptic to post-synaptic and not in the opposite direction. (Unidirectional flow).

## 2) Reflex delay:

Time between stimulation of receptor and response is called Reflex time.



### - Central time:

= Reflex time - time in (afferent + efferent).

- Synaptic Delay: It is the time taken by only one synapse  
= 0.3 msec.

- **No. of synapses** = Central time/synaptic delay.

# Properties of reflex Action



## 3) Fatigue:

Due to exhaustion of chemical transmitter.

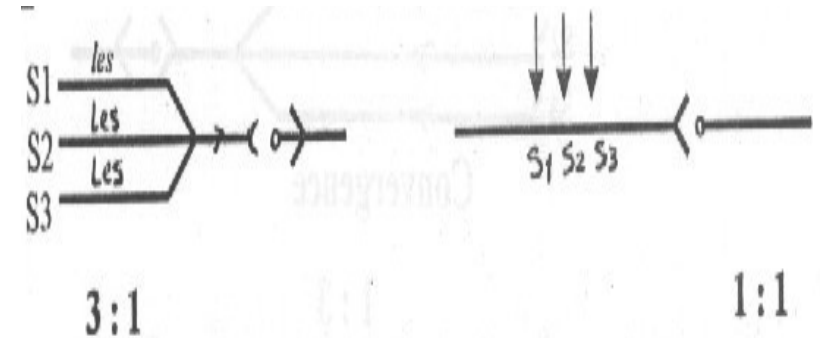
## 4) Summation

There are 2 types:

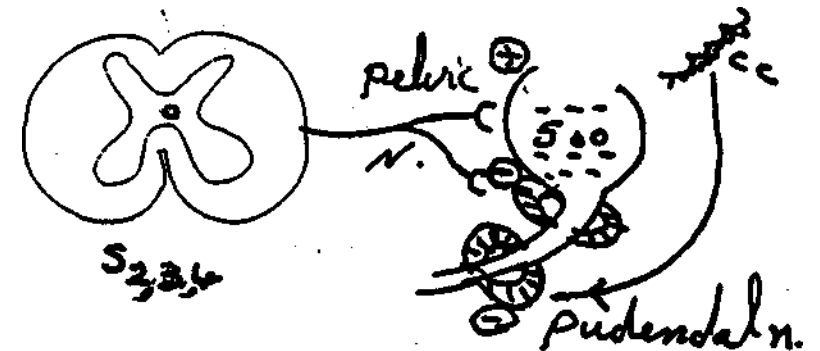


1 -Temporal: By repetitive stimulation of the same neuron at frequent times on the condition that time between each 2 successive stimuli is less than 15msec. EPSP.

2-Spatial: Stimuli from different levels at the same time, e.g.



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## ***Properties of reflex Action***



### **5) Irradiation:**

It is increasing the response with increased intensity of the stimulus, e.g. flexor withdrawal reflex due to the scratching of sole of foot with a rough object. It depends upon divergence.



### **Rebound:**

It is state of exaggerated response after initial period of inhibition.

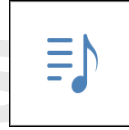
### **Examples:**

- a) After mosquito bite, if we do pin prick, this causes temporary inhibition of scratching followed by exaggerated scratching.

b) During crossed extensor reflex, if we do stimulation of the sole




Mention types of summation.



## ***Properties of reflex Action***



### **6- Reciprocal innervation.**

- Simultaneous contraction of certain group of muscles and relaxation of their antagonist, this is done by reciprocal inhibition circuits.
- This property is present  all reflexes **except positive supporting reaction.**

## ***Properties of reflex Action***



### **7) Recruitment:**

It is the gradual contraction of the muscle, inspite of sudden maximal stimulation.

### **Mechanism**

- Variation in thickness of Interneuron's.
- Variation in length of Interneuron's.
- Variation in excitability of motor units.

### **N.B:**

**Motor Unit:** A.H.C.+ its axon+ no of muscle fibers supplied by this axon.

**Motor Pool:** The no of motor units (AHCs) supplying the whole muscle.



# Properties of reflex Action



## 8) After discharge

**Def.:** It is continuation of discharge (response) after removal of the stimulus.

### Examples:

#### (I) RAS (arousal and alert states):

Arousal response is due to collateral impulses which are: Visual, auditory, & proprioceptive → stimulation of RAS → stimulation of thalamus → stimulation of C.C. → alert state, i.e. continuation of a wakefulness after removal of collateral impulses, caused by + ve feedback mechanism (example of after discharge).



C.C. → stimulation of thalamus → stimulation of RAS  
OR  
Direct

#### (II) Short term memory:

Continuation of storage of information's after removal of the stimulus, and it is removed only by stronger stimulus

# Properties of reflex Action



## (III) Flexor withdrawal reflex:

Continuation of flexion of elbow & shoulder joints inspite of removal of the limb away from site of injury.

### Mechanism:

#### (I) Synaptic after discharge:

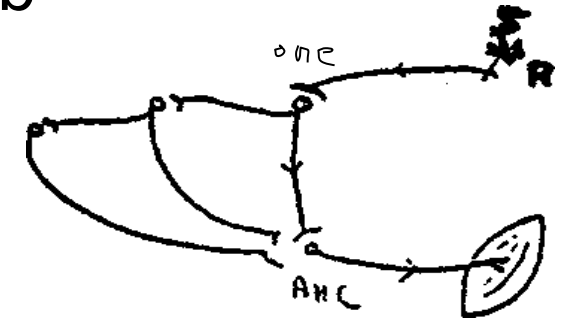
It is E.P.S.P. which lasts for 15 msec after removal of sub-threshold stimulus.



#### (II) Interneuronal after discharge:

##### 1-Parallel chain (open circuit):

Interneuron's connected with each other in parallel with intervening synapses, each synapse causes delay of 0.3-0.5 msec. Sudden removal of the stimulus doesn't cause sudden relaxation of the muscle.



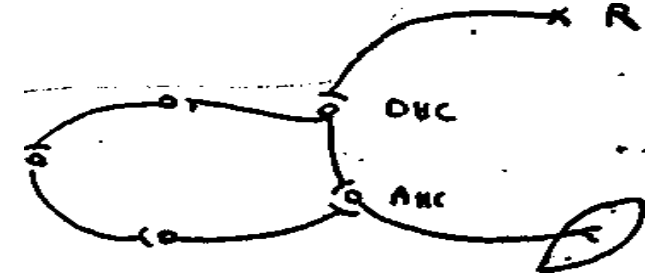
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# Properties of reflex Action



## 2-Re-verbration (closed circuit):


Interneuron's are connected with each other in series. These are responsible for prolongation of response, so any center which has transient and sudden action has no reverbrators, e.g. cerebellum

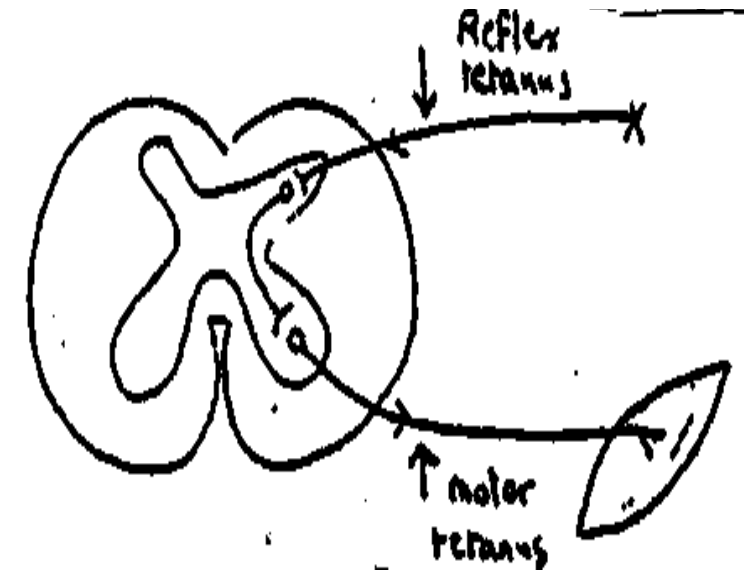


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# Properties of reflex Action



	Motor Tetanus	Reflex Tetanus
1.Cause	Stimulation of efferent	Stimulation of afferent
2. After discharge	Absent	 Present
3. Recruitment	Absent	Present
4. Delay (latent period)	No	Central



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# Properties of reflex Action



## 9) Discharge zone Subliminal fringe:

An afferent nerve fiber divides into many hundred branches. Of these, a large number may terminate on one efferent neuron, while a smaller number terminate on other efferent neuron lying nearby.



When an afferent neuron is stimulated, the central efferent neuron that has many presynaptic terminals is excited to threshold level and AP is fired (**discharging zone**).

Others in the peripheral zone are excited to subthreshold level only, i.e. their excitability is increased but an AP is not

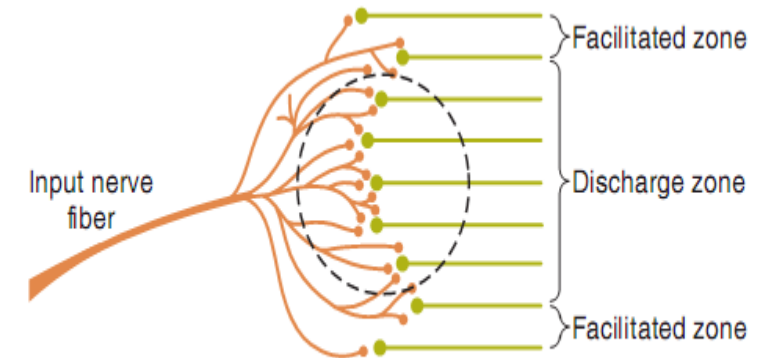


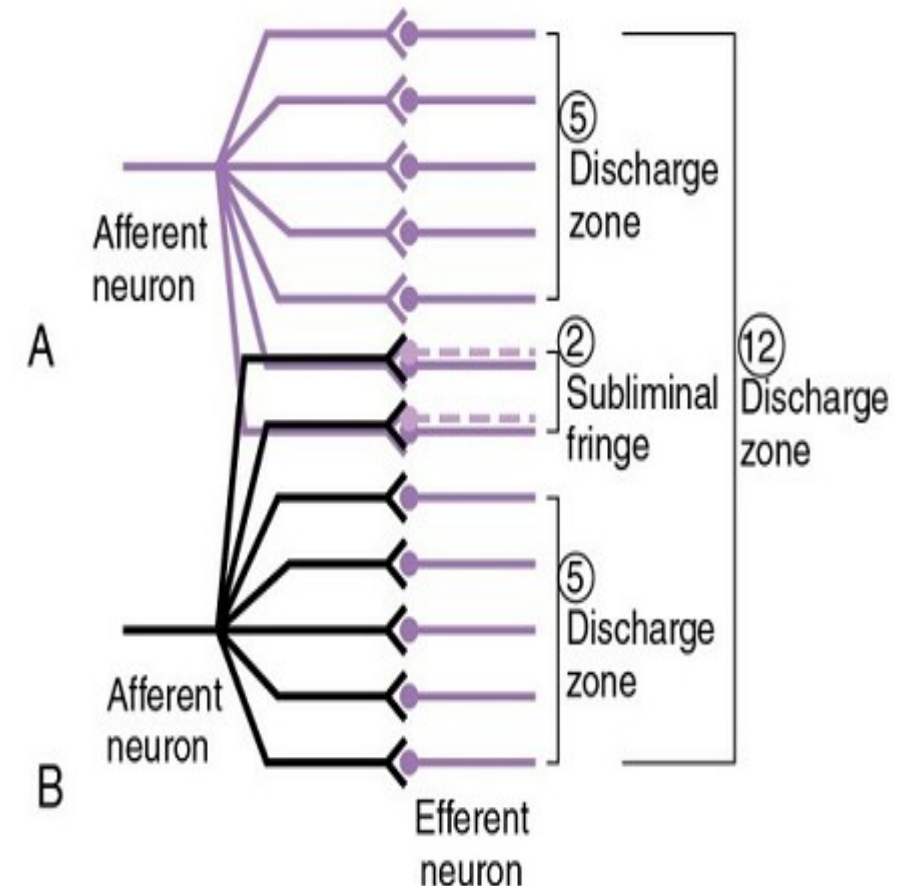
Figure 47-10. "Discharge" and "facilitated" zones of a neuronal pool.

Guyton and Hall, 2016

## ***Properties of reflex Action***



Because of subliminal fringe effect, stimulation of 2 nearby neurons with common interneuron with 2 sub-maximal stimuli gives → better response with synchronous stimulation (i.e. at the same time).



Textbook of Medical Physiology, SECOND EDITION, Indu Khurana, MD, 2015, Elsevier

# Properties of reflex Action



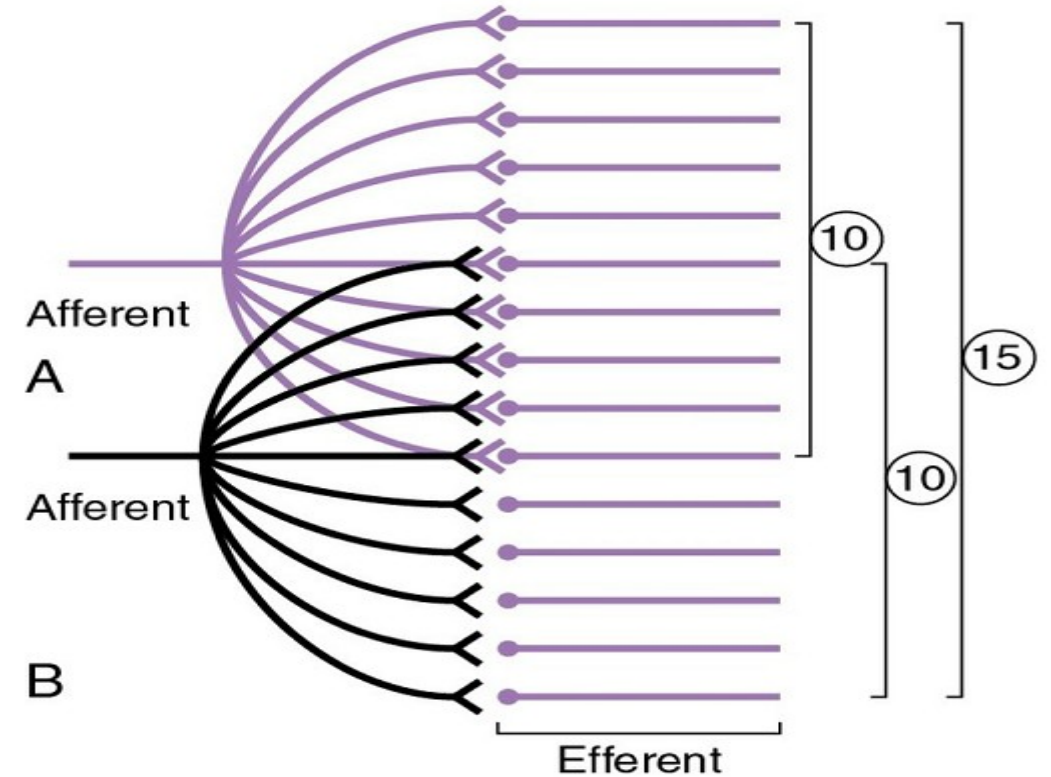
## 10) Occlusion:

Stimulation of 2 nearby afferents with maximal stimuli gives → better response with Asynchronous stimulation.



## 11) Facilitation:

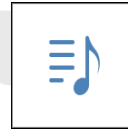
It depends upon spatial summation, e.g. micturition



Textbook of Medical Physiology, SECOND EDITION,  
Indu Khurana, MD, 2015, Elsevier



differentiate between motor tetanus & reflex tetanus








### 1- Which of the following is true about total reflex time?

- A. Needed from application of a stimulus to a receptor and the appearance of reflex contraction of a muscle.
- B. Needed from the entry of the nerve impulse in the spinal cord and its exit from it
- C. Needed for transmission of impulses across synapses.
- D. Needed for transmission of a neuronal signal from a presynaptic neuron to a postsynaptic neuron.
- E. Needed for transmission of a neuronal signal across interneurons.



### **2- The after discharge in a neural pool is based mainly upon which of the following?**

- A. After discharge of individual neurons.
- B. Reverberating & parallel interneuron circuits.
- C. Convergence & divergence uits.
- D. Occlusion.
- E. Recruitment.

# Summary



- Reflex arc is the functional and structural unit of CNS.**
- Law of forward conduction: Impulses pass from pre-synaptic to post-synaptic and not in the opposite direction. (Unidirectional flow).**
- Time between stimulation of receptor and response is called Reflex time.**
- Fatigue is Due to exhaustion of chemical transmitter.**
- Summation is either temporal or spatial.**
- Irradiation is increasing the response with increased intensity of the stimulus.**
- Reciprocal innervation is simultaneous contraction of certain group of muscles and relaxation of their antagonist.**
- Recruitment is the gradual contraction of the muscle, inspite of sudden maximal stimulation.**
- After discharge is continuation of discharge (response) after removal of the stimulus.**
- Because of subliminal fringe effect, stimulation of 2 nearby neurons with common interneuron with 2 sub-maximal stimuli gives better response with synchronous stimulation.**

## ***SUGGESTED TEXTBOOKS***



1. Guyton and Hall textbook of medical physiology, thirteenth edition 2016, Elsevier, chapter 47, from page 595 to 606.

***Thank You***